The Road to Free Flight: Delivery of Trajectory Intent Information to the Flight Deck

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Overview

- RTCA Task Force 3 Report on Free Flight
- Free Flight technologies
- Automatic Dependent Surveillance – Broadcast (ADS-B)
- ADS-B Technical Link Assessment Team (TLAT) Report
- Research Issues
- Information in Trajectory Change Reports
- Data Link Alternatives
- Suggestions for future research

Free Flight

- RTCA Task Force 3 Report
  - "Free Flight is a safe and efficient flight operating capability under instrument flight rules in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are only imposed to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through SUA, and to ensure safety of flight."
  - "The goal is not only to optimize the system, but to open the system for each user to self-optimize."

Technologies for Free Flight

- Decision Support Tools (DST)
  - CPDLC over VHF Digital Link (VDL) Mode 2, 3, or 4
  - Cockpit Display of Traffic Information (CDTI)
    - ADS-B over 1090 ES, UAT, or VDL Mode 4
    - Traffic Information Services – Broadcast (TIS-B)
  - Flight Information Services – Broadcast (FIS-B)

ADS-B

- “ADS-B is a function for airborne or surface aircraft, or other surface vehicles…, that periodically transmits its state vector (horizontal and vertical position, horizontal and vertical velocity) and other information. ADS-B is *automatic* because no external stimulus is required; it is *dependent* because it relies on on-board transmission systems….”

ADS-B TLAT Report

- Published in March 2001
- Evaluated three ADS-B data links
  - 1090 Extended Squitter
  - Universal Access Transceiver (UAT)
  - VHF Digital Link (VDL) Mode 4
- Findings on Transmission of Intent Information
  - 1090 ES: Applications unlikely to be met or not supported
  - UAT
    - TC+0 and TC+1 out to 90 nautical miles, supported
    - 4 TC Reports out to 150 nautical miles, not supported

Research Issues

- Characteristics of the data link to be used
- Amount of information to be transmitted within a given period with a specified probability of successful reception
- Transmitter power
- Receiver Sensitivity
- Spectrum and bandwidth issues
- Sources and nature of interference

Information Present in Trajectory Change Reports

- Taken from RTCA DO-242A ADS-B MASPS

- Participant Address, Address Qualifier, Time of Applicability
- TC Report Sequence #, TC Report Cycle #, TC Mgmt. Indicator
- Time to Go, Horizontal TC Type, TC Latitude, TC Longitude
- Turn Radius, Track to TCP, Track from TCP
- Horizontal Conformance, Horizontal Command Flag
- Vertical TC Type, TC Altitude, TC Altitude Type
- Altitude Constraint Type, Altitude Constraint (able / unable)
- Vertical Conformance, Vertical Command Flag

Data Link Alternatives for Intent Information Delivery

- 1090 MHz Extended Squitter
- VHF Digital Link Mode 4 (Self-organizing TDMA)
- Universal Access Transceiver
- VHF Digital Link Mode 2 (CSMA based)
- VHF Digital Link Mode 3 (TDMA voice & data)
- Satellite Communications Links

Suggestions for Future Research

- Modified UAT
  - Transmit on more than one frequency
  - Transmit with reduced power / range, but relayed along an ad-hoc network
  - Use of CDMA codes to combat interference
  - Alternative modulation and error correction coding schemes
- Brand new system from a blank sheet of paper
  - ???